Notice No. 4

Rules and Regulations for the Classification of Inland Waterways Ships, August 2011

The status of this Rule set is amended as shown and is now to be read in conjunction with this and prior Notices. Any corrigenda included in the Notice are effective immediately.

Issue date: July 2014

Amendments to	Effective date
Part 5, Chapter 1, Sections 2, 3, 4, 5 & 6	1 July 2014
Part 5, Chapter 2, Sections 1, 3, 4, 5, 6, 7, 8, 9, 10 & 11	1 July 2014
Part 5, Chapter 3, Sections 1, 3 & 5	1 July 2014
Part 5, Chapter 4, Sections 2 & 3	1 July 2014
Part 5, Chapter 5, Section 1	1 July 2014
Part 5, Chapter 6, Sections 2 & 5	1 July 2014
Part 5, Chapter 8, Section 1	1 July 2014
Part 5, Chapter 9, Sections 1, 2 & 3	1 July 2014
Part 5, Chapter 10, Sections 1, 2, 3, 4, 5, 6, 7, 8, 9 & 10	1 July 2014
Part 5, Chapter 11, Sections 1, 4, 7 & 10	1 July 2014
Part 5, Chapter 12, Sections 2, 3, 4, 9 & 10	1 July 2014
Part 5, Chapter 13, Sections 1, 2, 3, 4, 5, 6, 7, 8 & 9	1 July 2014
Part 5, Chapter 14, Sections 1, 2 & 6	1 July 2014
Part 5, Chapter 15, Sections 1, 2, 4 & 5	1 July 2014
Part 5, Chapter 16, Sections 2 & 5	1 July 2014
Part 5, Chapter 18, Section 2	1 July 2014

Lloyd's Register

Working together
for a safer world

Part 5, Chapter 1

General Requirements for the Design and Construction of Machinery

Effective Date 1 July 2014

■ *Section 2*
Plans and particulars

2.2 Materials

2.2.2 Materials used in the construction of machinery and its installation ~~should not be a recognised hazard to personnel~~ are not to contain asbestos.
~~This includes the prohibition of asbestos except in the following applications:~~
~~(a) Vanes used in rotary vane compressors and rotary vane pumps.~~
~~(b) Watertight joints and linings used for the circulation of fluids when at high temperature (in excess of 350ºC) or pressure (in excess of 7 x 10^6 Pa) there is a risk of fire, corrosion or toxicity.~~
~~(c) Supple and flexible thermal insulation assemblies used for temperatures above 1000ºC.~~

■ *Section 3*
Operating conditions

3.1 Availability for operation

3.1.2 Machinery is to be capable of operating at defined power ratings with a range of fuel grades specified by the engine, boiler or machinery manufacturer and agreed by the Owner/Operator.

3.1.3 Machinery is to be capable of operating satisfactorily in accordance with the manufacturer's stated operating conditions within an operational profile specified for the ship by the Owner/Operator and agreed by the manufacturer/system designer.

3.4 Definitions

3.4.3 Pressure gauges may be calibrated in bar, where
1 bar = 0,1 N/mm^2 ~~= 1,02 kgf/cm^2~~

■ *Section 4*
Machinery room arrangements

4.3 Ventilation

4.3.2 Machinery spaces with a total installed power rating exceeding 375 kW or containing oil fired equipment shall be ~~sufficiently~~ adequately ventilated so as to ensure that when machinery or boilers therein are operating at full power in all weather conditions, a sufficient supply of air is maintained to the spaces for the safety and comfort of personnel and the operation of the machinery. Any other machinery space shall be adequately ventilated, as appropriate for the purpose of that machinery space.

■ *Section 5*
Propulsion redundancy

5.1 Shaft system and steerable bow thruster

5.1.3 Combustion air for the main engines is not to be extracted from machinery spaces that are protected by permanently installed fire-fighting systems. This is not applicable when two independent completely separate machinery spaces are provided or if next to the main engine room a separate engine room has been provided with a bow thruster driven by its own source of power and capable of propelling the ship in the event of fire in the main machinery space.

■ *Section 6*
Trials

6.2 Trials

~~*6.2.7* The stopping distance achieved when the ship is initially proceeding ahead with a speed of 13 km/h in running water (running velocity 1,5 m/s) should be as follows:~~
~~(a) 550 m for ships having a length $L > 110$ m or breath $B > 14,5$ m, or~~
~~(b) 480 m for ships having a length $L \leq 110$ m or breath $B \leq 11,45$ m~~
~~The stopping distance achieved when the ship is initially proceeding ahead with a speed of 13 km/h in water having a running velocity of less than 0,2 m/s should be as follows:~~
~~(c) 350 m for ships having a length $L > 110$ m or breath $B > 14,5$ m, or~~
~~(d) 305 m for ships having a length $L \leq 110$ m or breath $B \leq 11,45$ m.~~

~~*6.2.8*~~ *6.2.7* All trials are to be to the Surveyor's satisfaction.

Part 5, Chapter 2

Oil Engines

Effective Date 1 July 2014

■ *Scope*

The requirements of this Chapter are applicable to oil engines (generally known as diesel engines) for main propulsion and to engines intended for essential auxiliary services. Section 3 is not applicable to auxiliary engines having powers of less than 110 kW.

The requirements for type testing of engines at the manufacturer's works are also included.

Arrangements for dual fuel engines and single-fuelled (gas) spark ignition or equivalent reciprocating engines will be specially considered.

Primary exhaust gas emissions abatement plant (where fitted) is to meet the requirements of this Chapter; additionally, it is to meet the requirements of Pt 5, Ch 24 of the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as the Rules for Ships). Where secondary exhaust gas emissions abatement systems are fitted to engines, they are to meet the requirements of Pt 5, Ch 24 of the Rules for Ships.

■ *Section 1*

Plans and particulars

1.1 Plans

1.1.1 The following plans and particulars as applicable are to be submitted for consideration:

- Crankshaft assembly plan (for each crank-throw).
- Crankshaft details plan (for each crank-throw).
- Thrust shaft or intermediate shaft (if integral with engine).
- Output shaft coupling bolts.
- Main engine securing arrangements where non-metallic chocks are used.
- Type and arrangement of crankcase explosion relief valves.
- Arrangement and welding specifications with details of the procedures for fabricated bedplate, thrust bearing bedplate, crankcases, frames and entablatures. Details of materials, welding consumables, fit-up conditions, fabrication sequence and heat treatments are to be included.
- Schematic layouts of the following systems~~, *see also* 1.1.4~~:
  Starting air.
  Fuel oil.
  Lubricating oil.
  Cooling water.
  Control and safety.
  Hydraulic oil.
- Shielding of high pressure fuel pipes.
- Combustion pressure-displacement relationship.
- Crankshaft design data as outlined in Section 3.
- High pressure parts of fuel oil injection system with specification of pressures, pipe dimensions and materials.
- For engine control, alarm monitoring and safety systems, the plans and information required by Pt 6, Ch 1,1.2 of the Rules for Ships.
- For electronically controlled engines, the plans and information required by 1.1.6.

~~*1.1.4* Where engines incorporate electronic control systems, a failure mode and effects analysis (FMEA) is to be submitted to demonstrate that failure of an electronic control system will not result in the loss of essential services for the operation of the engine and that operation of the engine will not be lost or degraded beyond an acceptable performance criteria of the engine. This is concerned with the functioning of the control system and not failure of the software itself.~~

Existing paragraph 1.1.6 *has been renumbered* 1.1.4.

~~*11.2.1*~~ *1.1.5* ~~In addition to the plans and particulars required by Section 1 the following information is to be submitted:~~

Where engines incorporate electronic control systems, the following additional information is to be submitted:

(a) A general overview of the operating principles, supported by schematics explaining the functionality of individual systems and sub-systems. The information is to relate to the engine capability and functionality under defined operating and emergency conditions such as recovery from a failure or malfunction, with particular reference to the functioning of programmable electronic ~~control~~ systems and any sub-systems. The information is also to indicate if the engine has different modes of operation, such as to limit exhaust gas emissions and/or to run under an economic fuel consumption mode or any other mode that ~~can be controlled by electronic control systems~~ is electronically controlled.

(~~e~~b) Operating manuals which describe the particulars of each system and, together with maintenance instructions, include reference to the ~~arrangements for making modifications and changes to electronic control systems and for the~~ functioning of sub-systems.

(c) ~~Failure Modes and Effects Analysis (FMEA)~~ A risk-based analysis of the mechanical, pressure containing, ~~and~~ electrical, electronic and programmable electronic systems and arrangements that support the operation of the engine. The analysis is to demonstrate that suitable risk mitigation has been achieved ~~so that a system will tolerate a single failure in equipment or loss of an associated sub-system such that operation of the engine will not be lost or degraded beyond acceptable performance criteria of the engine, *see* 11.5~~ in accordance with 4.2.

(~~b~~d) Details of hydraulic systems for actuation of sub-systems (fuel injection~~, air inlet and~~ or exhaust), to include details of the design/construction of pipes, pumps, valves, accumulators and the control of valves/pumps. Details of pump drive arrangements are also to be included.

~~(d) A schedule of testing and trials to demonstrate that the engine is capable of operating as described in the design statement, and any testing required to verify the conclusions of the FMEA.~~

(~~f~~e) Quality plan for sourcing, design, installation and testing of all components used in the oil fuel and hydraulic oil systems installed with the engine for engine operation.

(~~g~~f) Fatigue analysis for all high pressure oil fuel and hydraulic oil piping arrangements required for engine operation where failure of the pipe or its connection or a component would be the cause of engine unavailability. The analysis is to concentrate on high pressure components and sub-systems and recognise the pressures and fluctuating stresses that the pipe system may be subject to in normal service.

(~~j~~g) Evidence of type testing of the engine with ~~electronic controls~~ the programmable electronic system, or a proposed test plan at the engine builders with the ~~electronic controls~~ programmable electronic system functioning, to verify the functionality and behaviour under normal operation and fault conditions of the programmable electronic control system.

(h) Schedule of testing at Enginebuilders, ~~pre-sea~~ pre-river trial commissioning and ~~sea~~ river trials. The test schedules are to identify all modes of engine operation and the ~~sea~~ river trials are to include typical port manoeuvres under ~~all~~ the intended engine operating modes. The schedule is to include:
  - (i) testing and trials to demonstrate that the engine is capable of operating as described in (a);
  - (ii) tests to verify that the response of the complete mechanical, hydraulic, electrical and electronic system is as predicted for the intended operational modes; and
  - (iii) testing required to verify the conclusions of the risk-based analysis.

The scope of these tests is to be agreed with LR.

~~11.2.2~~ 1.1.6 In addition to the plans and particulars required by Pt 6, Ch 1,1.2.3 to 1.2.6 of the Rules for Ships the following information for control, alarm, monitoring and safety systems relating to the operation of an electronically controlled engine is to be submitted:

~~(a) System requirements specification.~~
~~(b) Description of operation with explanatory diagrams.~~
~~(c) Line diagrams of control circuits.~~
~~(d) List of monitored points.~~
~~(e) List of control points.~~
~~(f) List of alarm points.~~
~~(g) List of safety functions and details of any overrides, including consequences of use.~~
~~(h) Details of hardware configuration.~~
~~(j) Hardware certification details.~~
~~(k) Software quality plan.~~
~~(l) System integration plan.~~
~~(m) Failure Mode and Effects Analysis (FMEA). *See* 1.1.4.~~
~~(n) Factory acceptance, integration, harbour and sea trials/test schedules for hardware and software.~~
~~(o) Software certification details.~~
~~(p) Quality plan for sourcing, design installation and testing of all components used in the control, alarm, monitoring and safety systems installed with the engine for engine operation.~~
(a) Engine configuration details, *see* 4.3.2.
(b) Software quality plans, including configuration management documents.
(c) Software safety evidence.
(d) Software assessment inspection report.

~~10.1.1~~ 1.1.7 ~~The~~ For Turbo-chargers, the following plans and particulars are to be submitted for information:

- Cross sectional plans of the assembled turbo-charger with main dimensions.
- Fully dimensioned plans of the rotor.
- Material particulars with details of welding and surface treatments.
- Turbo-charger operating and test data.
- A selected turbo-charger is to be type tested.

~~1.1.5~~ 1.1.8 Where considered necessary, Lloyd's Register (hereinafter referred to as 'LR') may require additional documentation to be submitted.

■ *Section 3*
Design

3.5 Nominal stresses

(*Part only shown*)

3.5.4 Nominal alternating bending stress in the outlet of the crankpin oil bore:

~~$Z_{crankpin} = \frac{\pi}{32} \frac{(D^4 - d^4)}{D \times Z_{crankpin}}$ related to the cross-section of axially bored crankpin.~~

$$Z_{crankpin} = \frac{\pi}{32} \frac{(D^4 - d^4)}{D}$$

$Z_{crankpin}$ related to the cross-section of axially bored crankpin.

3.11 Shrink fit of semi-built crankshafts

3.11.1 For requirements, *see* ~~the *Rules and Regulations for the Classification of Ships* (hereinafter referred to as~~ the Rules for Ships~~)~~, Pt 5, Ch 2,3.11.

3.12 Alternative method for calculation of stress concentration factors

3.12.1 LR will give consideration to crankshaft design using an alternative method given in LR's ShipRight *Procedures for alternative method for calculation of stress concentration factors in the web fillet radii of crankshafts by utilising Finite Element*.

■ *Section ~~11~~ 4*
Electronically controlled engines

~~11.1~~ 4.1 ~~Scope~~ General

~~11.1.1~~ 4.1.1 The requirements of this Section are applicable to engines for propulsion~~, essential~~ and auxiliary ~~and emergency power~~ purposes with ~~software-based electronic control of fuel, air and exhaust systems~~ programmable electronic systems implemented and used to control fuel injection timing and duration, and which may also control combustion air or exhaust systems. The requirements of this Section also

apply to programmable electronic systems used to control other functions (e.g., starting and control air, cylinder lubrication, etc.) where essential for the operation of the engine.

~~*11.1.2*~~ *4.1.2* These engines may be of the slow, medium or high-speed type. They generally have no ~~camshaft to drive fuel, air and exhaust systems~~ direct camshaft-driven fuel systems, but have common rail fuel/hydraulic arrangements and may have hydraulic actuating systems for the functioning of the fuel, air and exhaust systems.

~~*11.1.3*~~ *4.1.3* The operation of these engines relies on the effective monitoring of a number of parameters such as crank angle, engine speed, temperatures and pressures using ~~one or more electronic control~~ programmable electronic systems to provide the services essential for the operation of the engine such as fuel injection, air inlet, exhaust and speed control.

~~*11.1.4*~~ *4.1.4* ~~Deviation from Rule requirements~~ Details of proposals to deviate from the requirements of this Section are to be submitted and will be considered on the basis of technical justification produced by the Enginebuilder.

4.1.5 Each engine is to be configured for the specified performance and is to satisfy the relevant requirements for propulsion, auxiliary engines.

~~*11.1.5*~~ *4.1.6* During the life of the engine ~~any changes to hardware, software, control and monitoring systems~~ details of any proposed changes to control, alarm, monitoring or safety systems which may affect ~~the~~ safety and the reliable operation of the engine are to be submitted ~~and approved by~~ to LR for approval.

~~11.5~~ 4.2 ~~FMEA~~ Risk-based analysis

4.2.1 An analysis is to be carried out in accordance with relevant standards acceptable to LR to demonstrate compliance with the applicable requirements of this sub-Section appropriate to the engine application. The analysis is to be a risk-based consideration of engine operation and ship and personnel safety, and is to demonstrate adequate risk mitigation through fault tolerance and/or reliability in accordance with the specified criteria in 4.2.2 to 4.2.4 relevant to the engine application.

~~*11.5.1*~~ *4.2.2* ~~A Failure Mode and Effects Analysis (FMEA) is to demonstrate that a failure of the functioning of an electronic control system:~~ For ships with a single main propulsion engine, a Failure Mode and Effects Analysis (FMEA),or alternative recognised analysis of system reliability, is to be carried out and is to demonstrate that an electronic control system failure:

(a) Will not result in the loss of the ability to provide the services essential for the operation of the engine, *see* ~~Pt 6, Ch 1,2.8.2~~ Pt 6, Ch 1,2.5.8 and 2.13.2 of the Rules for Ships;
(b) Will not affect the normal operation of the services essential for the operation of the engine other than those services dependent upon the failed part, ~~*see* Pt 6, Ch 1,2.9.4 and 2.9.5~~ Pt 6, Ch 1,2.14.4 and 2.14.5 of the Rules for Ships; and
(c) Will not leave either the engine, or any equipment or machinery associated with the engine, or the ship in an unsafe condition, *see* ~~Pt 6, Ch 1,2.3.8, 2.4.6 and 2.9.5~~ Pt 6, Ch 1,2.3.14, 2.4.6, 2.4.5, 2.10.3, 2.10.4 and 2.14.5 of the Rules for Ships.

4.2.3 A risk-based analysis is to be carried out for:

(a) main engines on ships with multiple main engines or other means of providing propulsion power; and/or
(b) auxiliary engines intended to drive electric generators forming the ship's main source of electrical power or otherwise providing power for essential services.

The analysis is to demonstrate that adequate hazard mitigation has been incorporated in electronically controlled engine systems or the overall ship installation with respect to personnel safety and providing propulsion power and/or power for essential services for the safety of the ship. Arrangements satisfying the criteria of 4.2.2(a) to (c) will also be acceptable.

~~*11.5.2*~~ *4.2.4* ~~Where FMEA analysis is required to be carried out the reports submitted are to address the following issues:~~ The risk-based analysis report is to:

(a) Identify the standards used for analysis and system design.
(b) Identify the engine, its purpose and the associated objectives of the analysis.
(c) Identify any assumptions made in the analysis.
(d) Identify the equipment, system or sub-system, mode of operation and the equipment.
(e) Identify potential failure modes and their causes.
(f) Evaluate the local effects (e.g., fuel injection failure) and the effects on the system as a whole (e.g., loss of propulsion power) of each failure mode.
(g) Identify measures for reducing the risks associated with each failure mode~~.~~ (e.g., system design, failure detection and alarms, redundancy, ~~This may be through system design, provision of redundant systems and/or~~ quality control procedures for sourcing, manufacture and testing, etc.).
(h) Identify trials and testing necessary to prove conclusions.

~~*11.5.3*~~ *4.2.5* At sub-system level it is acceptable to consider failure of equipment items and their functions, e.g., failure of a pump to produce flow or pressure head. It is not required that the failure of components within that pump be analysed, and failure need only be dealt with as a cause of failure of the pump.

4.3 Control engineering systems

4.3.1 Control, alarm, monitoring, safety and programmable electronic systems are to comply with Pt 6, Ch 1 of the Rules for Ships as applicable.

4.3.2 The engine control, alarm monitoring and safety systems are to be configured to comply with the relevant requirements (e.g., operating profile, alarms, shut-downs, etc.) of this Chapter and Pt 6, Ch 1 of the Rules for Ships for an engine for main or auxiliary purposes. Details of the engine configuration are to be submitted for consideration, identifying:

(a) Local and remote means to carry out system configuration.
(b) Engine builder procedures for undertaking configuring.

(c) Roles and responsibilities for configuration (e.g., Engine builder, engine packager, system integrator or other nominated party) with accompanying schedule.
(d) Configurable settings and parameters (including those not to be modified from a default value).
(e) Configuration for propulsion, auxiliary engine application.

Configuration records are to be maintained and are to be made available to the Surveyor at testing and trials and on request in accordance with Pt 6, Ch 1,1.4 and 7.1.3 of the Rules for Ships.

4.4 Software

4.4.1 Software lifecycle activities are to be carried out in accordance with an acceptable quality management system, see Pt 6, Ch 1,2.13.2 and 2.13.7 of the Rules for Ships.

4.4.2 Appropriate safety related processes, methods, techniques and tools are to be applied to software development and maintenance by the Engine builder. Selection and application of techniques and measures in accordance with Annex A of IEC 61508-3, *Functional safety of electrical/electronic/programmable electronic systems: Software requirements*, or other relevant standards or codes acceptable to LR, will generally be acceptable.

4.4.3 To demonstrate compliance with 4.4.1 and 4.4.2:
(a) software quality plans and safety evidence are to be submitted for consideration, see 4.2.2 (b) and (c); and
(b) an assessment inspection of the Engine builder's completed development is to be carried out by LR. The inspection is to be tailored to verify application of the standards and codes used in software safety assurance accepted by LR.

■ *Section ~~4~~ 5*
Construction and welded structures

Existing sub-Sections 4.1 *to* 4.5 *have been renumbered* 5.1 *to* 5.5.

■ *Section ~~5~~ 6*
Safety arrangements on engines

Existing sub-Sections 5.1 *to* 5.4 *have been renumbered* 6.1 *to* 6.4.

■ *Section ~~6~~ 7*
Crankcase safety fitting

Existing sub-Sections 6.1 *to* 6.5 *have been renumbered* 7.1 *to* 7.5.

■ *Section ~~7~~ 8*
Piping

~~7.1~~ 8.1 Oil fuel, hydraulic and high pressure oil systems

~~11.3.1~~ 8.1.1 Oil fuel and hydraulic oil piping systems arrangements are to comply with Chapters ~~2,~~ 10~~, 11,~~ and 12 ~~and 13~~ as applicable.

~~7.1.3~~ 8.1.2 Oil fuel pipe systems in general, tanks and their fittings are to comply with the requirements of Chapter 12 and Part 3.

~~11.3.2~~ 8.1.3 ~~Where pumps are essential for engine operation, not less than two oil fuel and two hydraulic oil pressure pumps are to be provided for their respective service and arranged such that failure of one pump does not render the other inoperative.~~ Each oil fuel pump and hydraulic oil pump essential for engine operation is to be capable of supplying the quantity of oil for engine operation at its maximum continuous rating ~~and arranged ready for immediate use~~.

~~7.1.1~~ 8.1.4 All external high pressure fuel delivery lines between the high pressure fuel pumps and fuel injectors are to be protected with a jacketed piping system capable of containing fuel from a high pressure line failure. If flexible hoses are used for shielding purposes, these arrangements are to be approved.

~~11.3.4~~ 8.1.5 The hydraulic oil pressure piping between the high pressure hydraulic pumps and hydraulic actuators is to be protected with a jacketed piping system capable of containing hydraulic oil leakage from a high pressure pipe failure.

~~7.2~~ ~~High pressure oil systems~~

~~7.2.1~~ 8.1.6 Where flammable oils are used in high pressure systems, the oil pipe lines between the high pressure oil pump and actuating oil pistons are to be protected with a jacketed piping system capable of preventing oil spray from a high-pressure line failure.

~~11.3.5~~ 8.1.7 Accumulators and associated high pressure piping are to be designed, manufactured and tested in accordance with a standard applicable to the maximum pressure and temperature rating of the system.

8.1.8 Diesel engine fuel system components are to be designed to accommodate the maximum peak pressures experienced in service. In particular, this applies to the fuel injection pump supply and spill line piping which may be subject to high-pressure pulses from the pump. Connections on such piping systems should be chosen to minimise the risk of pressurised oil fuel leaks.

~~7.1.2~~ 8.1.9 The protection is to prevent oil fuel or oil fuel mist from reaching a source of ignition on the engine or its surroundings. Suitable drainage arrangements are to be made for draining any oil fuel leakage to a collector tank(s) ~~or other approved means~~ fitted in a safe position. An alarm is to be provided to indicate that leakage is taking place.

~~*11.3.6*~~ *8.1.10* All valves, cocks and screwed connections are to be of a type tested type applicable to the maximum service conditions anticipated in normal service.

~~*11.3.7*~~ *8.1.11* Isolating valves and cocks are to be located as near as practicable to the equipment to be isolated. All valves forming part of the oil fuel and hydraulic oil installation are to be capable of being controlled from readily accessible positions above the working platform.

~~*11.3.8*~~ *8.1.12* High pressure oil fuel and high pressure hydraulic oil piping systems are to be provided with high pressure alarms with set points that do not exceed the system design pressures.

~~*11.3.9*~~ *8.1.13* High pressure oil fuel and high pressure hydraulic piping systems are to be provided with suitable relief valves on any part of the system that can be isolated and in which pressure can be generated. The settings of the relief valves are not to exceed the design pressures. The valves are to be of adequate size and so arranged as to avoid an undue rise in pressure above the design pressures.

~~*11.3.10*~~ *8.1.14* Equipment fitted for monitoring pressures and temperatures in the high pressure oil fuel and high pressure hydraulic oil systems is to comply with a Recognised Standard suitable to the anticipated vibration and temperature conditions.

~~*11.3.11*~~ *8.1.15* A fatigue analysis is to be carried out in accordance with a standard applicable to the system under consideration and all anticipated pressure, pulsation and vibration loads are to be addressed. The analysis is to demonstrate that the design and arrangements are such that the likelihood of failure is as low as reasonably practicable. The analysis is to identify all assumptions made and standards to be applied during manufacture and testing of the system. Any potential weak points which may develop due to incorrect construction or assembly are also to be identified.

~~*11.3.12*~~ *8.1.16* For high pressure oil containing and mechanical power transmission systems, the quality plan for sourcing, design, installation and testing of components is to address the following issues:

(a) Design and manufacturing standard(s) applied.
(b) Materials used for construction of key components and their sources.
(c) Details of the quality control system applied during manufacture and testing.
(d) Details of type approval, type testing or approved type status assigned to the machinery or equipment.
(e) Details of installation and testing recommendations for the machinery or equipment.

~~7.3~~ 8.2 Exhaust systems

Existing paragraphs 7.3.1 *to* 7.3.4 *have been renumbered* 8.2.1 *to* 8.2.4.

~~7.4~~ 8.3 Starting air pipe systems and safety fittings

Existing paragraphs 7.4.1 *to* 7.4.7 *have been renumbered* 8.3.1 *to* 8.3.7.

■ *Cross-references*

The pumping arrangements, including cooling water and lubricating oil systems, are to comply with the requirements of Chapter 12.

■ *Section ~~8~~ 9*

Starting arrangements, air compressors and batteries

~~8.1~~ 9.1 Air compressors

9.1.5 Air compressors are to be in accordance with Ch 2, 16 of the Rules for Ships, which includes requirements for the design, materials, safety precautions and for the manufacture and testing of air compressors.

Existing sub-Sections 8.2 *and* 8.3 *have been renumbered* 9.2 *and* 9.3.

■ *Section ~~9~~ 10*

Component tests and engine type testing

Existing sub-Sections 9.1 *and* 9.2 *have been renumbered* 10.1 *to* 10.2.

■ *Section ~~10~~ 11*

Turbo-chargers

~~10.1 Plans and particulars~~

Existing paragraph 10.1.1 *has been renumbered* 1.1.7.
Existing sub-Sections 10.2 *to* 10.5 *have been renumbered* 11.1 *to* 11.4.

~~■ *Cross-references*~~

Cross-references have moved to end of Section 8.

■ *Section 11*

Electronically controlled engines

This Section has been deleted and paragraphs have been moved to other Sections throughout this Chapter.

~~*11.3.3* The oil fuel pressure piping between the oil fuel high pressure pumps and the fuel injectors is to be protected with a jacketed piping system capable of containing oil fuel leakage from a high pressure pipe failure.~~

Existing sub-Section 11.4 *has been deleted in its entirety.*

~~*11.5.4* In an electronically controlled engine it is necessary to define the essential services on which the operation of the engine relies and the control functions, alarm functions and safety functions for the equipment and machinery providing these services. Examples of essential services are:~~

~~(a) Starting arrangements.~~
~~(b) Fuel supply arrangements.~~
~~(c) Lubricating oil arrangements.~~
~~(d) Hydraulic oil arrangements.~~
~~(e) Cooling arrangements.~~
~~(f) Power supply arrangements.~~

Part 5, Chapter 3

Gearing

Effective Date 1 July 2014

■ *Scope*

The requirements of this Chapter, except where otherwise stated, are applicable to oil engine gearing for main propulsion purposes and for oil engine gearing for driving auxiliary machinery which is essential for the safety of the ship or for safety of persons on board where the transmitted powers exceed 220 kW for propulsion drives, and 110 kW for auxiliary drives. Alternatively, calculations using the methods defined in ISO 6336 – *Calculation of load capacity of spur and helical gears* will be considered. In any mesh, the terms ‘pinion’ and ‘wheel’ refer to the smaller and larger gear respectively. Bevel gears will be specially considered on the basis of a conversion to equivalent helical gears. For torsional vibration requirements, *see* Ch 6,2.3.

■ *Section 1*

Plans and particulars

1.1 Gearing plans

1.1.1 Particulars of the gearing are to be submitted with the plans for all propulsion gears and for auxiliary gears where the transmitted power exceeds 110 kW, as follows:

(a) Plans and information demonstrating conformance with the applicable Rules and Standards as stated in scope.
(b) Shaft power and revolution for each pinion.
(c) Number of teeth in each gear.
(d) Reference diameters.
(e) Helix angles at reference diameters.
(f) Normal pitches of teeth at reference diameters.
(g) Tip diameters.
(h) Root diameters.
(j) Face widths and gaps, where applicable.
(k) Pressure angles of teeth (normal or transverse) at reference diameters.
(l) Accuracy grade Q in accordance with ISO 1328 or an equivalent standard.
(m) Surface texture of tooth flanks and roots.
(n) Minimum backlash.
(o) Centre distance.
(p) Basic rack tooth form.
(q) Protuberance and final machining allowance.
(r) Details of post hobbing processes, if any.
(s) Details of tooth flank corrections, if adopted.
(t) Case depth for surface-hardened teeth.
(u) Shrinkage allowance for shrunk-on rims and hubs.
(v) Type of coupling proposed for oil engine applications.

■ *Section 3*

Design

3.1 Symbols

(*Part only shown*)

3.1.1 For the purposes of this Chapter, the following symbols apply:

h_F = bending moment arm for root stress, in mm
h_W = sum of actual tooth addenda of pinion and wheel, in mm
m_n = normal module, in mm
Q = accuracy grade derived from ISO 1328 ~~– 1975~~ Cylindrical gears – ISO system of accuracy

3.7 Design of enclosed gear shafting

(*Part only shown*)

3.7.3 The diameter of the enclosed gear shafting adjacent to the pinion or wheel is to be not less than the greater of d_b or d_t, where:
~~where~~

$$\cancel{d_t = 365\left(\frac{P}{R\,S_s}\right)^{1/6}}$$

$$d_t = 365\left(\frac{P}{R\,S_s}\right)^{1/3}$$

■ *Section 5*
Tests

5.3 Backlash

5.3.1 The normal backlash between any pair of gears should not be less than:

$$\frac{a\alpha_{\mathrm{n}}}{90000} + 0{,}1 \text{ mm}$$

5.3.2 The normal backlash is not to exceed three times the value calculated in 5.3.1.

Existing sub-Section 5.3 *has been renumbered* 5.4.

Part 5, Chapter 4
Main Propulsion Shafting

Effective Date 1 July 2014

■ *Section 2*
Materials

2.1 Materials for shafts

2.1.1 The specified minimum tensile strength of forgings for shafts is to be selected within the following general limits:

(a) Carbon and carbon-manganese steel 400 to 760 N/mm². *See also* 3.4.2.
(b) Alloy steel not exceeding 800 N/mm².

■ *Section 3*
Design

3.3 Thrust shafts and ~~external to engines~~ thrust shaft bearing arrangements

3.3.1 ~~The diameter collars of the thrust shaft transmitting torque, or in way of the axial bearing where a roller bearing is used as a thrust bearing, is to be not less than that required for the intermediate shaft in accordance with 3.2.1 with a *k* value of 1,10. Outside a length equal to the thrust shaft diameter from the collars, the diameter may be tapered down to that required for the intermediate shaft with a *k* value of 1,0. For the purpose of the foregoing calculations,~~ ~~σ_u~~ ~~is to be taken as the minimum tensile strength of the thrust shaft material, in N/mm². The fillet radius at the base of both sides of the thrust collar is to be not less than 0,08 of the diameter of the shaft at the collar.~~
Thrust shafts and thrust shaft bearing arrangements situated outside the gearbox or engine, with collar block arrangements or axial roller thrust bearings, will be specially considered. For thrust shafts inside the gearbox, *see* Ch 3,3.7.8.

Part 5, Chapter 5
Propellers

Effective Date 1 July 2014

■ *Section 1*
Plans and particulars

1.1 Details to be submitted

1.1.5 Where it is proposed to fit the propeller to the screwshaft without the use of a key, plans of the boss, tapered end of screwshaft~~, propeller nut and where applicable, the sleeve, are to be submitted~~ and propeller nut are to be submitted.

Part 5, Chapter 6
Shaft Vibration and Alignment

Effective Date 1 July 2014

■ *Section 2* Torsional vibration

2.3 Scope of calculations

2.3.3 The calculations carried out on oil engine systems are to be based on the Enginebuilder's harmonic torque data. ~~(On request, Lloyd's Register (hereinafter referred to as LR) can provide a table of generalised harmonic torque components for use where appropriate.)~~ The calculations are to take account of the effects of engine malfunction commonly experienced in service, such as a cylinder not firing. Calculations are also to take account of a degree of imbalance between cylinders, which is characteristic of the normal operation of an engine under service conditions.

2.4 Symbols and definitions

2.4.5 **Stress concentration factor of slots.** The stress concentration factor (*scf*) at the end of the slots can be determined by means of the following empirical formulae: ~~This formula applies to:~~

$$scf = \alpha_t(hole) + \cancel{0{,}57}\ 0{,}8 \times \frac{\dfrac{(l-e)}{d}}{\sqrt{\left(1-\dfrac{d_i}{d}\right) \times \dfrac{e}{d}}}$$

This formula applies to:

- Slots at 120 or 180 or 360 degrees apart
- Slots with semicircular ends. A multi-radii slot end can reduce the local stresses, but this is not included in this empirical formula.
- Slots with no edge rounding (except chamfering), as any edge rounding increases the *scf* slightly

$\alpha_t(hole)$ represents the stress concentration of radial holes and can be determined as:

$$\alpha_t(hole) = 2{,}3 - 3 \times \frac{e}{d} + 15 \times \left(\frac{e}{d}\right)^2 + 10 \times \left(\frac{e}{d}\right)^2 \times \left(\frac{d_i}{d}\right)^2$$

where

e = hole diameter, in mm or simplified to $\alpha_t(hole) = 2{,}3$.

■ *Section 5* Shaft alignment

5.2 Particulars to be submitted for approval – shaft alignment calculations

5.2.1 Shaft alignment calculations are to be submitted to LR for approval for the following shafting systems:

(a) all geared installations, where the screwshaft has a diameter of 300 mm or greater in way of the aftmost bearing, except for multiple input/single output geared installations, in which case all such installations will be submitted for approval;

(b) where prime movers in a direct drive installation or shaftline bearings are installed on resilient mountings.

(*Part only shown*)

5.2.2 The shaft alignment calculations are to take into account the:

(e) gear forces, where appropriate, due to prime-mover engagement on multiple-input/single-output installations. For multiple input systems, consideration is to be given to each possible combination of inputs;

Part 5, Chapter 8
Fired Boilers

Effective Date 1 July 2014

■ *Section 1* General requirements

1.1 Application

1.1.3 Where exhaust gas emissions abatement equipment is fitted to steam raising plant, it is to meet the requirements of Pt 5, Ch 24 of the Rules for Ships.

Part 5, Chapter 9

Pressure Vessels other than Boilers

Effective Date 1 July 2014

■ *Section 1*
General requirements

1.5 Classification of fusion welded pressure vessels

1.5.9 For a full definition of Classes of pressure vessels relating to boilers and associated pressure vessels, *see* Pt 5, Ch 10,1 of the Rules for Ships.

1.7 Materials

1.7.1 Materials used in the construction of Class 1, 2/1 and 2/2 pressure vessels are to be manufactured, tested and certified in accordance with the requirements of the Rules for Materials. Materials used in the construction of Class 3 pressure vessels may be in accordance with the requirements of an acceptable national or international specification. The manufacturer's certificate will be accepted in lieu of ~~LR's~~ Lloyd’s Register’s (hereinafter referred to as LR’s) material certificate for such materials.

1.9 Joint factors

(*Part only shown*)
1.9.2
For typical acceptable methods of attaching flat ends, *see* Fig. 9.6.1.
For typical acceptable methods of attaching dished ends, ~~see~~ *see* Fig. ~~9.6.1~~ 9.7.1.

■ *Section 2*
Cylindrical shells and drums subject to internal pressure

2.3 Reinforced openings

(*Part only shown*)
2.3.1
t_b = actual thickness of standpipe without minus tolerances and corrosion allowance, in mm
t_d = thickness calculated in accordance with ~~7.1~~ 5.1.1 without corrosion allowance, in mm

■ *Section 3*
Dished ends subject to internal pressure

3.1 Minimum thickness

(*Part only shown*)
3.1.3

$$\cancel{H = R_o - [(R_o - 0{,}5D_o)(R_o + 0{,}5D_o - 2r_o)]^{1/2}}$$

$$H = R_o - \sqrt{(R_o - 0{,}5D_o)(R_o + 0{,}5D_o - 2r_o)}$$

(*Part only shown*)
3.1.5 The thickness required by 3.1.1 for the knuckle section of a torispherical head is to extend past the common tangent point of the knuckle and crown radii into the crown section for a distance not less than $\cancel{0{,}5(R_i\,t)^{1/2}}$ $0{,}5\sqrt{R_i\,t}$ mm, before reducing to the crown thickness permitted by 3.1.4 where

3.3 Dished ends with unreinforced openings

(*Part only shown*)
3.3.2 The upper curves in Fig. 9.3.1 provide values of K to be used in 3.1.1, for ends with unreinforced openings. The selection of the correct curve depends on the value $\cancel{\frac{d}{(D_o t)}^{1/2}}$ $\frac{d}{\sqrt{(D_o t)}}$ and a trial calculation is necessary to select the correct curve,

3.3.4 From Fig. 9.3.1 for any selected ratio of $\frac{H}{D_o}$ the curve for unpierced ends gives a value for $\cancel{\frac{d^{1/2}}{(D_o t)}}$ $\frac{d}{\sqrt{(D_o t)}}$ as well as for K. Openings giving a value of $\cancel{\frac{d^{1/2}}{(D_o t)}}$ $\frac{d}{\sqrt{(D_o t)}}$ not greater than ~~the~~ the value so obtained may thus be pierced through an end designed as unpierced without any increase in thickness.

3.6 Dished ends with reinforced openings

(*Part only shown*)
3.6.2 Reinforcing material within the following limits may be taken as effective reinforcement:
(a) The effective width l_1 of reinforcement is not to exceed $\cancel{(2R_i)^{1/2}\,t}$ $\sqrt{2R_i\,t}$ or $0{,}5d_o$, whichever is the lesser.
(b) The effective length l_2 of a reinforcing ring is not to exceed $\cancel{(d_o\,t_b)^{1/2}}$ $\sqrt{d_o\,t_b}$

where

R_i = the internal radius of the spherical part of a torispherical end, in mm, or

R_i = the internal radius of the meridian of the ellipse at the centre of the opening, of a semi-ellipsoidal end, in mm, and is given by the following formula:

$$\cancel{\frac{[a^4 - x^2 (a^2 - b^2)]^{3/2}}{a^4 b}}$$

$$\frac{\sqrt{(a^4 - x^2 (a^2 - b^2))^3}}{a^4 b}$$

Part 5, Chapter 10

Piping Design Requirements

Effective Date 1 July 2014

■ *Section 1* General

1.1 Application

1.1.4 The piping systems for Type G tankers and gas fuelled ships are to comply with the relevant Sections of this Chapter where applicable and the additional requirements in Section 9, as well as the requirements in Chapter 13.

1.6 Materials

1.6.2 The manufacturer's test certificate for materials for pipes, valves and fittings of Class I and Class II piping systems will be accepted in lieu of LR's materials certificate where the maximum nominal pipe diameter is less than 50 mm or the product of working pressure in bar times nominal diameter in mm is less than 2500. *See* Ch 1,3.1.3(c) of the Rules for Materials.

1.6.3 For copper alloys having a working temperature < 200°C, the manufacturer's test certificate for materials for pipes, valves and fittings of Class I and Class II piping systems will be accepted in lieu of LR's materials certificate where the maximum nominal pipe diameter is less than 50 mm or the product of working pressure in bar times nominal diameter in mm is less than 1500. *See* Ch 1,3.1.3(c) of the Rules for Materials.

1.6.4 The manufacturer's ~~test~~ certificate for materials for ship-side valves and fittings and valves on the collision bulkhead equal to or less than 500 mm nominal diameter will be accepted in lieu of LR's materials certificate where the valves and fittings are in accordance with a recognised National Standard applicable to the intended application and are manufactured and tested in accordance with the appropriate requirements of Ch 1,3.1.3(c) of the Rules for Materials.

■ *Section 2* Carbon and low alloy steels

2.1 Carbon and low alloy steel pipes, valves and fittings

2.1.2 Materials for Class III piping systems are to be manufactured and tested in accordance with the requirements of acceptable national specifications. Pipes having forge butt welded longitudinal seams are not to be used for oil fuel systems, for heating coils in oil tanks, or for pressures exceeding 4,0 bar. The manufacturer's ~~test~~ certificate will be acceptable and is to be provided for each consignment of material. *See* Ch 1,3.1.3(c) of the Rules for Materials.

2.2 Wrought steel pipes and bends

(*Part only shown*)

2.2.1 The maximum permissible design stress, σ, is to be taken as the lowest of the following values:

$$\sigma = \frac{E_t}{1,6} \qquad \sigma = \frac{R_{20}}{2,7}$$

where

E_t = specified minimum lower yield or 0,2 per cent proof stress at the design temperature. In the case of austenitic stainless steels, the 1,0 per cent proof stress at design temperature is to be used.

R_{20} = specified minimum tensile strength at ambient temperature.

2.2.8 Where the minimum thickness calculated by 2.2.4 or 2.2.5 is less than that shown in Table 10.2.3, the minimum nominal thickness for the appropriate standard pipe size shown in the Table is to be used. No allowance is required for negative tolerance, corrosion or reduction in thickness due to bending on this nominal thickness. For larger diameters, the minimum thickness will be specially considered. For threaded pipes, where permitted, the minimum thickness is to be measured at the bottom of the thread.

2.8 Welded sleeve joints

2.8.4 The thickness of the sleeve is to satisfy the requirements of 2.2.4 and Table 10.2.3 but is to be not less than 1,42 times the nominal thickness of the pipe in order to satisfy the throat thickness required in 2.8.5. The radial clearance between the outside diameter of the pipe and the internal diameter of the sleeve is not to exceed 1 mm for pipes up to a nominal diameter of 50 mm, 2 mm on diameters up to 200 mm nominal size and 3 mm for larger size pipes. The pipe ends are to be separated by a clearance of approximately 2 mm at the centre of the sleeve. Alternatively, consideration will be given to sleeve thickness in accordance with a relevant National Standard.

2.8.5 The sleeve material is to be compatible with the associated piping and the leg lengths of the fillet weld connecting the pipe to the sleeve are to be such that the throat dimension of the weld is not less than ~~0,7 times~~ the nominal thickness of the pipe or tube.

Table 10.2.4 Limiting design conditions for threaded sleeve joints

Thread type	Outside pipe diameter, in mm		
	Class I	Class II	Class III
Tapered thread	<33,7	<60,3	<60,3
Parallel thread	—	—	<60,3

2.11 Other mechanical couplings

2.11.11 Restrained slip-on joints are permitted in steam pipes with a design pressure of 10 bar or less on the weather decks of oil and chemical tankers to accommodate axial pipe movement, *see* Ch 11, 2.7.

2.11.12 Mechanical joints are to be tested in accordance with a program approved by LR, which is to include the following tests as relevant to the service conditions and the intended application:

- leakage test;
- vacuum test (where necessary);
- vibration (fatigue) test;
- fire endurance test (where necessary);
- burst pressure test;
- assembly test (where necessary);
- pull out test (where necessary);
- static displacement/misalignment test (where necessary).

Table 10.2.5 Application of mechanical joints *(Part only shown)*

Systems	Kind of connections		
	Pipe unions	Compression couplings (6)	Slip-on joints
Miscellaneous			
Starting/Control air (1)	+	+	—
Service air (Non-essential)	+	+	+
Brine	+	+	+
CO_2 system	+	+	—
Steam	+	+	~~–7~~ +7

Section 3
Copper and copper alloys

3.1 Copper and copper alloy pipes, valves and fittings

3.1.2 Materials for Class III piping systems are to be manufactured and tested in accordance with the requirements of acceptable National Specifications. The manufacturer's ~~test~~ certificate will be acceptable and is to be provided for each consignment of material. *See* Ch 1,3.1.3(c) of the Rules for Materials.

Section 4
Cast iron

4.1 Spheroidal or nodular graphite cast iron

4.1.3 ~~Castings for Class II and Class III systems are to be manufactured and tested in accordance with the requirements of acceptable National Specifications. *See also* 1.6.~~ Castings for Class II and Class III systems are to comply with the requirements of acceptable national specifications. A manufacturer's certificate will be accepted and is to be provided for each consignment of material, *see also* 1.6 and Ch 1,3.1.3(c) of the Rules for Materials.

■ *Section 5*
Plastics pipes

5.2 Design and performance criteria

5.2.4 Plastics piping, ~~is~~ connections and fittings are to be electrically conductive when:

(a) Carrying fluids capable of generating electrostatic charges.

(b) Passing through ~~dangerous~~ hazardous zones and spaces, regardless of the fluid being conveyed.

Suitable precautions against the build-up of electrostatic charges are to be provided in accordance with the requirements of 5.5. *See also* Pt 6, Ch 2,1.7.

5.6 Manufacture and quality control

5.6.1 All materials for plastics pipes and fittings are to be approved by LR, and are in general to be tested in accordance with Ch 14, 4 of the Rules for Materials. For pipes and fittings not employing hand lay-up techniques, the hydrostatic pressure test required by Ch 14,4.9 of the Rules for Materials may be replaced by testing carried out in accordance with the requirements stipulated in a National or International Standard, consistent with the intended use for which the pipe or fittings are manufactured, provided there is an effective quality system in place complying with the requirements of Ch 14,4.4 of the Rules for Materials and the testing is completed to the satisfaction of the LR Surveyor.

■ *Section ~~7~~ 6*
Valves

~~7.1~~ 6.1 Design requirements

~~7.1.1~~ 6.1.1 The design, construction and operational capability of valves is to be in accordance with an acceptable National or International Standard appropriate to the piping system. Where valves are not in accordance with an acceptable standard, details are to be submitted for consideration. Where valves are fitted, the requirements of ~~7.1.2~~ 6.1.2 to ~~7.1.15~~ 6.1.15 are to be satisfied.

Existing paragraphs 7.1.2 *to* 7.1.15 *have been renumbered* 6.1.2 *to* 6.1.15.

■ *Section ~~8~~ 7*
Flexible hoses

~~8.1~~ 7.1 General

Existing paragraphs 8.1.1 *to* 8.1.6 *have been renumbered* 7.1.1 *to* 7.1.6.

~~8.1.7~~ 7.1.7 The number of flexible hoses in piping systems mentioned in this Section is to be kept to a minimum and to be limited for the purpose stated in ~~8.2.1~~ 7.2.1.

Existing paragraphs 8.1.8 *to* 8.1.12 *have been renumbered* 7.1.8 *to* 7.1.12.

~~8.2~~ 7.2 Applications

Existing paragraphs 8.2.1 *and* 8.2.2 *have been renumbered* 7.2.1 *and* 7.2.2.

~~8.2.3~~ 7.2.3 Rubber ~~or plastics~~ hoses, with single, ~~or~~ double or more closely woven integral wire braid or other suitable material reinforcement, or convoluted metal pipes with wire braid protection, may be used in bilge, ballast, compressed air, fresh water, outboard-water, oil fuel, lubricating oil, Class III steam and hydraulic and thermal oil systems. Flexible hoses of plastics materials for the same purposes, such as Teflon or nylon, which are unable to be reinforced by incorporating closely woven integral wire braid are to have suitable material reinforcement as far as practicable.

Existing paragraphs 8.2.4 *to* 8.2.7 *have been renumbered* 7.2.4 *to* 7.2.7.

~~8.3~~ 7.3 Design requirements

Existing paragraphs 8.3.1 *and* 8.3.2 *have been renumbered* 7.3.1 *and* 7.3.2.

~~8.3.3~~ 7.3.3 Flexible hose assemblies intended for installation in piping systems where pressure pulses and/or high levels of vibration are expected to occur in service~~,~~ are to be designed for the maximum expected impulse peak pressure and forces due to vibration. The tests required by ~~8.4~~ 7.4 are to take into consideration the maximum anticipated in-service pressures, vibration frequencies and forces due to installation.

Existing paragraphs 8.3.4 *and* 8.3.5 *have been renumbered* 7.3.4 *and* 7.3.5.

~~8.4~~ 7.4 Testing

Existing paragraph 8.4.1 *has been renumbered* 7.4.1.

~~8.4.2~~ 7.4.2 For a particular hose type complete with end fittings, the tests, as applicable, are to be carried out on different nominal diameters for pressure, burst, impulse and fire resistance in accordance with the requirements of the relevant standard. The following standards are to be used as applicable:

- ISO 6802 – *Rubber and plastics hoses and hose assemblies with wire reinforcements – Hydraulic ~~pressure~~ impulse test with~~out~~ flexing.*
- ISO 6803 – *Rubber ~~and~~ or plastics hoses and hose assemblies – Hydraulic-pressure impulse test without flexing.*
- ISO 15540 – *Ships and marine technology – Fire resistance of hose assemblies – Test methods.*
- ISO 15541 – *Ships and marine technology – Fire resistance of hose assemblies – Requirements for test bench.*
- ISO 10380 – *Pipe-work – Corrugated metal hoses and hose assemblies.*

Other standards may be accepted where agreed by LR.

Existing paragraph 8.4.3 *has been renumbered* 7.4.3.

■ Section ~~9~~ 8
Hydraulic tests on pipes and fittings

~~9.1~~ 8.1 Hydraulic tests before installation on board

~~9.1.1~~ 8.1.1 All Class I and II pipes and their associated fittings are to be tested by hydraulic pressure to the Surveyor's satisfaction. Further, all steam, feed, compressed air and oil fuel pipes, together with their fittings, are to be similarly tested where the design pressure is greater than ~~3,5~~ 7,0 bar. The test is to be carried out after completion of manufacture and before installation on board and where applicable, before insulating and coating.

Existing paragraphs 9.1.2 *to* 9.1.7 *have been renumbered* 8.1.2 *to* 8.1.7.

~~9.2~~ 8.2 Testing after assembly on board

Existing paragraph 9.2.1 *has been renumbered* 8.2.1.

~~9.2.2~~ 8.2.2 Where pipes specified in ~~9.1.1~~ 8.1.1 are butt welded together during assembly on board, they are to be tested by hydraulic pressure in accordance with the requirements of ~~9.1~~ 8.1 after welding. The pipe lengths may be insulated, except in way of the joints made during installation and before the hydraulic test is carried out.

~~9.2.3~~ 8.2.3 The hydraulic test required by ~~9.2.2~~ 8.2.2 may be omitted provided non-destructive tests by ultrasonic or radiographic methods are carried out on the entire circumference of all butt welds with satisfactory results. Where ultrasonic tests have been carried out, the manufacturer is to provide the Surveyor with a signed statement confirming that ultrasonic examination has been carried out by an approved operator and that there were no indications of defects which could be expected to have a prejudicial effect on the service performance of the piping.

Existing paragraph 9.2.4 *has been renumbered* 8.2.4.

■ Section 9
~~Hydraulic tests on pipes and fittings~~ Piping for Type G tankers and gas fuelled ships

9.1 Scope

9.1.1 This Section is applicable to piping systems installed on Type G tankers and gas fuelled ships for the following pipes and piping system components:

(a) Pipe work: stainless steel, carbon steel and copper.
(b) Valves: normal and cryogenic service (below minus 55°C).
(c) Bellows: normal and cryogenic service (below minus 55°C).
(d) Pipe fittings: elbows, reducers, tee connections, etc.
(e) Ancillary fittings: weldolets, threadolets, thermo pockets.

9.1.2 The following piping systems are covered by this Section:

(a) LPG/LNG cargo systems: normal cargo operations.
(b) LNG cargo systems: gas burning and use of cargo as fuel.
(c) LNG Regasification system: high and low pressure.
(d) Gas storage and supply systems for gas fuelled ships.

9.1.3 In addition to the requirements of this Chapter, the *Rules for the Classification of Natural Gas Fuelled Ships* are to be complied with as far as they are applicable.

9.2 Application

9.2.1 The requirements of this Section apply to pipes and piping system components, such as valves, elbows and bellows, which are to be used on Type G tankers and gas fuelled ships. The requirements are also applicable to other gas cargo services such as regasification systems and gas combustion units, and are in addition to the relevant Sections of this Chapter and Chapter 13, where appropriate.

9.3 Classes of pipe

9.3.1 The material requirements for piping systems vary depending on the Class of the piping system. The Class of the piping system is dependent on the design pressure or temperature of the system and the pipe material used, as shown in Table 10.1.1.

9.3.2 As referred to in Table 10.1.1, piping systems containing LPG/LNG, cargo or fuel gas as the conveyed medium are to be treated as 'Flammable liquids'. These piping systems are to be categorised as Class II. Vapour lines are also to be categorised as Class II systems but the upper limit on pressure may be increased to 40 bar in accordance with the 'Other media'. Where higher design pressures are applied, such as in a re-gasification system, liquid lines above 16 bar and vapour lines above 40 bar are to be categorised as Class I. All open-ended pipes, such as vent lines and pipes inside the cargo tanks may be categorised as Class III.

9.4 Materials

9.4.1 Stainless steel pipes, valves and fittings are to be grades 304L, 316L, 321 or 347 in accordance with Ch 6,5 of the Rules for Materials.

9.4.2 The materials used in Class I and Class II systems are to be produced at a works approved by LR. Testing is to be in accordance with the Rules for Materials and Tables 6.1 and 6.4 in Chapter 6 of the *Rules for Ships for the Carriage of Liquefied Gases in Bulk* (hereinafter referred to as the Rules for Ships for Liquefied Gases).

9.4.3 For stainless steel pipes, valve castings and forgings intended for service temperatures down to minus 55°C, an LR materials certificate is required, unless:

- $DN < 50$ or
- $DN \leq 150$ and $DN \times P < 2500$

where a manufacturer's material certificate is acceptable.

9.4.4 For pipe systems operating at cryogenic temperatures lower than minus 55°C, an LR materials certificate is required.

9.4.5 Properties of materials other than stainless steel are to be submitted and will be specially considered.

9.5 Valves and piping components independent of temperature

9.5.1 For valves and piping components fitted in the cargo piping system of Type G tankers, each type of valve and piping component is to have evidence of satisfactory type testing.

9.6 Valves for cryogenic temperature service

9.6.1 Each size and type of valve intended to be used at a working temperature below –55ºC should be subjected to a tightness test to the minimum design temperature or lower, and to a pressure not lower than the design pressure of the valve. During the test the satisfactory operation of the valve should be ascertained. The tightness test is to be conducted in accordance with a recognised National or International Code or Standard.

9.7 Expansion bellows

9.7.1 The following plans and particulars are to be submitted:

(a) Dimensioned drawings of each type of bellows.

(b) Design calculations to show that the bellows are suitable for the intended design conditions, carried out to EJMA (Expansion Joint Manufacturers Association) standards (latest edition) or equivalent.

(c) A proposed prototype test program covering the tests detailed in Ch 5,5.3.2.2 of the Rules for Ships for Liquefied Gases.

(d) Calculations to EJMA standards may be accepted, together with sample testing detailed above, in order to cover the entire size range for the type.

9.7.2 In accordance with Ch 5,5.3 of the Rules for Ships for Liquefied Gases, the requirements for type testing in 9.8.3 to 9.8.7 are to be performed on each type of expansion bellows intended for use on LPG/LNG piping.

9.7.3 For each type of expansion bellows, an element of the bellows, not pre-compressed, is to be pressure tested at not less than five times the design pressure without bursting. This test is to be conducted at room temperature on each ‘type’ of element and need not be the complete bellows unit. A test on one element can cover other sized bellows with the same cross-sectional bellows form. The design pressure is to be at least 10 bar; bellows fitted to safety valves and vent lines may have a minimum design pressure of 5 bar in accordance with Ch 5,5.2.3.3 of the Rules for Ships for Liquefied Gases. The required test duration is not to be less than 5 minutes.

9.7.4 A pressure test is to be performed on each type of expansion joint complete with all the accessories such as flanges, stays and articulations, at twice the design pressure at the extreme displacement conditions recommended by the manufacturer without permanent deformation. The test is to be undertaken at the minimum design temperature, unless the bellows material is stainless steel, for which this test may be carried out at ambient temperature. The test duration is to be 30 minutes unless otherwise agreed with LR.

9.7.5 A cyclic thermal movement test, replicating the cooling down and warming up cycle which occurs during cargo loading and discharge, is to be performed on a complete expansion joint, by the application of representative external deflection resulting in bellows movement. This is successfully to withstand at least as many cycles, under the conditions of pressure, temperature, axial movement, rotational movement and transverse movement, as it will encounter in actual service. The number of cycles is to be estimated by the Builder and depends on the ship’s intended trading pattern and life expectancy. As a minimum, testing to 7000 cycles is to be carried out. The test is to be carried out at between 2-5 cycles per second. Testing at ambient temperature is permitted when this testing is at least as severe as testing at the service temperature. The maximum movements on the horizontal and vertical axis are to be provided by the Builders and obtained from their stress analysis; however, the test can be extended to any value which is greater than that expected, or to the maximum deflection for which the bellows unit is suitable. Movements in the test need not be in both horizontal and vertical directions, but the horizontal-vertical box diagonal distance may be used. NDE testing is required after cyclic testing.

9.7.6 A cyclic fatigue test, representing ship deformation, is to be performed on a complete expansion joint, without internal pressure, by simulating the bellows movement corresponding to a compensated pipe length, for at least 2 000 000 cycles at a frequency not higher than 5 cycles per second. The test may be waived if the piping arrangement experiences ship deformation loads. NDE is required after cyclic testing.

9.7.7 The cyclic thermal movement test and cyclic fatigue test may be waived by LR if satisfactory documentation is provided to establish the suitability of the expansion joints to withstand the expected working conditions. Where the maximum internal pressure exceeds 1,0 bar gauge, this documentation is to include sufficient test data to justify the design method used, with particular reference to correlation between calculation and test results.

9.8 Pressure testing of piping and other piping components

9.8.1 Pressure testing is to be undertaken in accordance with specific Rule requirements relating to the system in which the component is to be located.

9.8.2 The duration for which pressure tests are to be held is to be in conjunction with an applicable and recognised Code or Standard acceptable to LR.

9.9 Equipment documentation

9.9.1 A certificate is required for each piping component supplied to be fitted in a Class I or Class II system. This certification is required for each size and type of equipment delivered. A single certificate may cover a number of valves, provided that they are of the same type and size, and serial numbers have been included on the certificate. If the piping components are part of a system fitted to a skid or packaged unit, then the complete skid may be supplied with a single certificate stating that the package has been constructed using approved materials, approved and tested in accordance with LR Rule requirements.

9.10 Relief valves for LPG/LNG cargo and deck tanks

9.10.1 Relief valves fitted to cargo tanks and deck tanks are to be of a type tested design. Type testing is to include:

- flow or capacity verification to a recognised Standard acceptable to the Administration;
- cryogenic testing when operating at design temperatures colder than minus 55°C;
- seat tightness testing to a recognised Standard or manufacturer's procedure acceptable to the Administration; and
- pressure testing of pressure-containing parts to at least 5 times the design pressure.

9.10.2 The materials used for construction of relief valves fitted to cargo tanks and deck tanks are to be produced in a works approved by LR and be provided with a Lloyd's Register Material Certificate.

■ *Section ~~6~~ 10*

Austenitic stainless steels

~~6.1~~ 10.1 General

~~6.1.1~~ 10.1.1 Stainless steels may be used for a wide range of services and are particularly suitable for use at elevated temperatures. For guidance on the use of stainless steels in outboard water systems, *see* ~~10.3.4~~ 11.3.4.

Existing paragraph 6.1.2 *has been renumbered* 10.1.2.

~~6.1.3~~ 10.1.3 Where stainless steel is used in lubricating and hydraulic oil systems, ~~corrosion allowance is not required~~ the corrosion allowance may be reduced to 0 mm. For pipes passing through tanks, an additional corrosion allowance is to be added to take account of external corrosion; the addition will depend on the external medium and the value is to be in accordance with Table 12.2.3. Where the pipes are efficiently protected, the corrosion allowance may be reduced by not more than 50 per cent.

~~6.1.4~~ 10.1.4 In no case is the thickness of the stainless steel pipes ~~is~~ to be less than that shown in Table ~~10.6.1~~ 10.10.1.

Existing paragraphs 6.1.5 *and* 6.1.6 *have been renumbered* 10.1.5 *and* 10.1.6.

Table 10.10.1 Minimum thickness for austenitic stainless steel pipes

Standard pipe sizes (outside diameter), in mm			Minimum thickness, in mm
10,2	to	17,2	1,0
21,3	to	48,3	1,6
60,3	to	88,9	2,0
114,3	to	168,3	2,3
219,1			2,6
273			2,9
323,9	to	406,4	3,6
over 406,4			4,0

NOTE
The external diameters and thicknesses have been selected from ISO Standard 1127:1980. Diameter and thicknesses according to other National or International Standards may be accepted.

■ *Section ~~10~~ 11*

Guidance notes on metal pipes for water services

Existing Section 10 *has been renumbered Section* 11.

Part 5, Chapter 11

Ship Piping Systems

Effective Date 1 July 2014

■ *Section 1*

General requirements

1.1 Application

1.1.6 Piping design is to comply with Chapter 10 as applicable.

1.3 Plans and particulars

(*Part only shown*)

1.3.1 The following plans (in diagrammatic form) and particulars are to be submitted for approval. Additional plans should not be submitted unless the arrangements are of a novel or special character affecting classification:

(s) Arrangements of flammable liquids used for ~~power transmission,~~ control and heating systems.

(t) Arrangements of power transmission systems for services essential for safety or for the operation of the ship on the inland waterway.

(~~t~~u) Arrangements of cooling water systems for main and auxiliary services.

(~~u~~v) Oil fuel tanks and lubricating and hydraulic oil tanks with a capacity of 500 litres or more, not forming part of the ship's structure.

(~~v~~w) Arrangements and dimensions of all steam pipes, with details of flanges, bolts and weld attachments, and particulars of the material of pipes, flanges, bolts and electrodes.

(~~w~~x) Arrangements and details of box coolers for main and auxiliary services.

~~(x) Details verifying compliance of demands on low pressure air systems by essential systems as required by Ch 12,10.~~

■ *Section 4*
Bilge drainage of machinery spaces

4.2 Submersible pump drainage

4.2.1 For ships other than passenger ships where a bilge main is not fitted, the branch bilge suction referred to in 4.1.1 and 4.1.3 may be replaced by a suction from fixed installed submersible pumps in accordance with 6.6. The second bilge suction is to be either a second fixed installed submersible bilge pump or a direct bilge suction as detailed in 5.3. The capacity of each pump is to be in accordance with 6.3 with d_m calculated as the main bilge in accordance with 5.1.1.

■ *Section 7*
Pipe systems and their fittings

7.4 Hold and other compartment suctions – Strum boxes

7.4.1 The open ends of bilge suctions in holds and other compartments outside machinery spaces such as cofferdams and tanks other than those permanently arranged for the carriage of fresh water, water ballast, oil fuel or liquid cargo and for which other efficient means of pumping are provided are to be enclosed in strum boxes. ~~having~~ The strum boxes are to be provided with perforations of not more than 10 mm diameter, whose combined area is not less than twice that required for the suction pipe. The boxes are to be so constructed that they can be cleared without breaking any joint of the suction pipe.

■ *Section 10*
Air and sounding pipes

10.5 Termination of air pipes

10.5.1 Air pipes to double bottom tanks, deep tanks extending to the shell plating, or tanks which can be run up from the waterway are to be led to above the deck. Air pipes to oil fuel and cargo oil tanks, cofferdams and all tanks which can be pumped up are to be led to the open as follows:

(~~b~~a) For height of air pipes above deck for fuel oil tanks on ships carrying dangerous goods or tankers, *see* Pt 4, Ch 1,12.5.3 and/or Pt 4, Ch 4,3.4.1.

(~~a~~b) For height of air pipes above deck, in general, *see* Pt 3, Ch 11,10.

10.13 Elbow sounding pipes

10.13.1 In passenger ships, elbow sounding pipes are not permitted.

10.13.2 Elbow sounding pipes are not to be used for deep tanks unless the elbows and pipes are situated within closed cofferdams or within tanks containing similar liquids. They may, however, be fitted to other tanks and may be used for sounding bilges, provided that it is not practicable to lead them directly to the tanks or compartments, and subject to any sub-division and damage stability requirements that may apply.

10.13.3 The elbows are to be of heavy construction and adequately supported.

Existing sub-Sections 10.13 *and* 10.14 *have been renumbered* 10.14 *and* 10.15.

Part 5, Chapter 12

Machinery Piping Systems

Effective Date 1 July 2014

Section 2
Oil fuel – General requirements

2.1 Flash point

~~*2.1.3* Tanks containing oil fuel are to be separated from crew, passenger and baggage compartments by either:~~

- ~~a gastight steel division additional to the division which retains the oil, or~~
- ~~a division of all welded steel construction capable of withstanding a head of water at least 1,5 m greater than the maximum service head.~~

2.1.3 Where it is proposed to use gaseous fuels for main or auxiliary engines in inland waterways ships, and permitted by the national or regional administration, the relevant requirements of the *Rules and Regulations for the Classification of Natural Gas Fuelled Ships* are to be complied with and full details of the proposed arrangements are to be submitted for special consideration.

2.6 Precautions against fire

2.6.10 Where level switches are used below the tank top, they are to be contained in a steel enclosure or other enclosures which provide equivalent protection against fire.

2.8 Tank and cofferdams

2.8.1 Tanks containing oil fuel/lubricating oil are to be separated from passenger, crew and baggage compartments by a gastight and watertight boundary or alternatively by a cofferdam.

2.8.2 A cofferdam between the passenger, crew and baggage compartments is mandatory when the common bulkhead is subject to a static liquid pressure under normal service conditions.

2.8.3 Any cofferdam adjacent to an oil fuel/lubricating oil tank is to be suitably ventilated and drained.

Section 3
Oil fuel burning arrangements

3.4 Quick-closing valve

3.4.1 A quick-closing master valve is to be fitted to the oil supply to each thermal oil heater or boiler manifold, suitably located so that the valve can be readily operated in an emergency, either directly or by means of remote control, having regard to the machinery arrangements and location of controls. A quick-closing master valve is not required to be fitted if the thermal oil heater has a dedicated quick-closing valve fitted to the oil fuel daily service tank to which it is connected providing the heater and tank are in close proximity (*see* Ch 12,4.6).

3.5 Spill arrangements

3.5.1 Provision is to be made, by suitable non-return arrangements, to prevent oil from spill systems being returned to the burners when the oil supply to these burners has been shut off.

Section 4
Oil fuel pumps, pipes, fittings, tanks, etc.

4.2 Relief valves on pumps

4.2.1 All pumps which are capable of developing a pressure exceeding the design pressure of the system are to be provided with relief valves or approved equivalent means. Each relief valve is to be in closed circuit, i.e., arranged to discharge back to the suction side of the pump and to effectively limit the pump discharge pressure to the design pressure of the system.

4.2.2 Where centrifugal type pumps are fitted, pressure-relief valves will not be required, provided that pipes, valves and fittings are suitable for the greater of the design pressure or pump non-delivery pressure.

4.4 Pipes conveying oil

4.4.5 For requirements relating to flexible hoses, *see* Ch 10,7.

Existing paragraphs 4.4.5 *to* 4.4.9 *have been renumbered* 4.4.6 *to* 4.4.10.

Section 9
Hydraulic systems

9.1 General

9.1.1 The requirements of this Section are applicable to flammable oils employed under pressure in power transmission, control, actuating and heating systems.

~~*9.1.1*~~ *9.1.2* The arrangements for storage, distribution and utilisation of hydraulic and ~~other~~ flammable oils employed ~~under pressure in power transmission systems, control and actuating systems in locations where means of ignition are present,~~ in the systems defined in 9.1.1 are to comply, where applicable, with the provisions of:

- 2.6.1 to 2.6.3, Precautions against fire.
- 4.1, Control of pumps.
- 4.2, Relief valves on pumps.
- 4.4, Pipes conveying oil.
- 4.10, Separate oil fuel tanks.
- 4.6.1, Valve or cock secured to the tank.

9.2 System arrangements

~~*9.2.3* Over-pressure protection is to be provided on the discharge side of all pumps. Where relief valves are fitted for this purpose, they are to be fitted in closed circuit, i.e. arranged to discharge back to the system oil tank.~~

Existing paragraphs 9.2.4 *to* 9.2.9 *have been renumbered* 9.2.3 *to* 9.2.8.

■ *Section 10*
Low pressure compressed air systems

10.1 General

10.1.1 The requirements of this Section are applicable to low pressure (LP) compressed air systems ~~which are essential for~~ intended for essential pneumatic control and instrumentation purposes.

10.4 Distribution system

10.4.2 Low pressure compressed air distribution pipes led to the dangerous area of a tanker are to be provided with a spring-loaded non-return valve situated in the dangerous area directly after the bulkhead/deck penetration.

Part 5, Chapter 13
Piping Systems for Ships Intended for the Carriage of Liquids in Bulk

Effective Date 1 July 2014

■ *Section 1*
General requirements

1.3 Materials

1.3.2 Materials for cargo piping systems are to comply with the requirements of Chapter 10 as follows:
Class I or II systems for Type G Tankers depending on the service. *See also* Ch 10,9.3.
Class II systems for Type C Tankers.
Class II for Type N Tankers carrying toxic or corrosive media.
Class III for all other Type N Tankers.

1.3.4 Where stainless steel is required or accepted as an alternative to mild steel ~~then~~, it is to be essentially an austenitic or duplex type and comply with the appropriate requirements of the *Rules for the Manufacture, Testing and Certification of Materials* (hereinafter referred to as the Rules for Materials). Alternative austenitic or duplex grades of stainless steel may be accepted provided they comply with National or Proprietary specifications and are suitable for the intended purpose.

1.3.5 For materials used on board Type G tankers carrying LPG, reference is made to Ch 10,9.4 for additional requirements.

Existing paragraphs 1.3.5 *to* 1.3.9 *have been renumbered* 1.3.6 *to* 1.3.10.

1.6 Cargo pump-room

Table 13.1.1 Alarms and safety arrangements

Item	Alarm	Note
Temperature sensing of bulkhead shaft glands, bearings and pump casings	High *see* Note	Cargo, ballast and stripping pumps
Bilge level	High	–
Hydrocarbon concentration	High	> 10% LEL

NOTE
The alarm signals shall trigger continuous visual and audible alarms ~~in the cargo control room or the pump control station~~ at the position from which the cargo pumps will be controlled and in a permanently manned location.

1.9 Bulkhead penetrations

1.9.4 ~~Pipes from the machinery space led to the open, may pass through the pump room/cofferdam/wing tank in the cargo area or a hold space containing the cargo tanks, provided that within these spaces the pipes are of seamless steel and of substantial wall thickness and have no flanged joints or openings.~~
Pipes from the machinery space led to the open may pass through the pump-room/cofferdam/wing tank in the cargo area or a hold space containing the cargo tanks to the open, provided that, within the spaces mentioned above, they are:

- of substantial wall thickness
- without flanged joints or openings
- as short as practicable.

■ *Section 2*
Piping systems for bilge, ballast, oil fuel, etc.

2.1 Pumping arrangements at ends of ship

2.1.4 Where non-permanent connections are required in piping systems between non-hazardous and hazardous spaces, two means of isolation are to be provided. One of these means is to provide positive separation by means of a removable spool piece or flexible hose, and blank flanges are to be fitted. The other is to be a non-return valve, or similar, in accordance with an acceptable national or international Standard that is appropriate for the design conditions of the piping system. The non-return valve and removable piece are to be located within the existing hazardous spaces. A notice is also to be provided located in a prominent position adjacent to the means of isolation, clearly indicating that the spool piece or flexible hose is to be removed, and blanking flanges are to be fitted, when the piping is not in use. The removable spool piece is to be clearly identified (labelled/painted in a distinctive colour) and stowed close to its working position.

2.2 Drainage and/or ballasting of spaces within the cargo zone

2.2.10 Bilge or ballast pumps serving spaces within the cargo zone other than cargo tanks may be placed ~~only~~ outside that zone only under the following conditions:

- All Types of tankers; for wing tanks and double bottom tanks not having a common boundary with the cargo tanks.
- Type G tankers; for cofferdams and hold spaces containing cargo tanks if ballasting will be carried out through a flexible connection with the fire main. Upon completion of the ballast operation, the fire main must be disconnected from the relevant spaces. The cofferdams and hold spaces are to be drained by bilge ejectors.
- Type N and C tankers; for cofferdams, wing tanks, double bottom tanks and hold spaces containing cargo tanks if ballasting will be carried out through a flexible connection with the fire main. Upon completion of the ballast operation, the fire main must be disconnected from the relevant spaces. The cofferdams and hold spaces are to be drained by bilge ejectors.

  As an alternative to a flexible connection, a fixed connection with a spectacle flange could be accepted. Upon completion of the ballast operation the fire main must be separated from the relevant spaces by fitting the spectacle flange in the 'closed' position.

■ *Section 3*
Cargo handling system

3.2 Cargo pumps and compressors

3.2.3 Pump suction and discharge pressure gauges are to be provided at the pumps or compressors~~,~~ (except for the suction side of deep well pumps). The pressure gauges are to be readable at the pump control stations at all times.

3.3 Cargo piping systems

3.3.4 ~~Expansion joints of approved type or bends are to be provided, where necessary, in the cargo pipe lines. Mechanical joints of the slip type may be used only in cargo oil lines. *See also* Ch 11,2.7.2 and Table 10.2.5 in Chapter 10.~~ Suitable provision for expansion is to be made, where necessary, in the cargo pipe lines as follows:

- Type G tankers are to be provided with bends. Alternatively, expansion bellows of approved type may be fitted, *see* Ch 10,9.7.
- Type C and N tankers are to be provided with expansion joints of approved type or bends, *see* Ch 11,2.7.2 and Table 10.2.5 in Chapter 10.
- Tankers carrying only cargoes listed in Part 4, Ch 6,10.1.1 may be provided with mechanical joints of the slip-on type, *see* Table 10.2.5 in Chapter 10.

3.3.5 Stainless steel expansion bellows used in piping systems are to be protected against over extension and compression and adjoining pipes are to be suitably supported and anchored. Reference is made to recognised Standards such as EJMA & BS6129 Pt 1 for acceptable methods of support and anchoring.

Existing paragraphs 3.3.5 *to* 3.3.10 *have been renumbered* 3.3.6 *to* 3.3.11.

~~*3.3.11*~~ *3.3.12* The requirements of ~~3.3.12~~ 3.3.13 to ~~3.3.17~~ 3.3.18 apply to product and process piping including vapour piping and ventlines of safety valves or similar piping intended for Type G tankers.

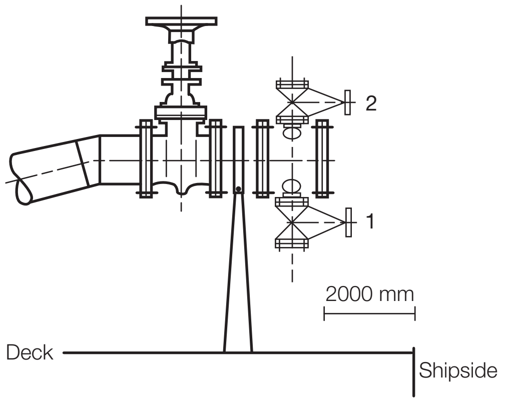
Existing paragraphs 3.3.12 *to* 3.3.15 *have been renumbered* 3.3.13 *to* 3.3.16.

~~*3.3.16*~~ *3.3.17* Flanges, valves and other fittings should comply with ~~Recognised~~ recognised Standards, taking into account the maximum applicable gauge pressure. For bellows expansion joints used in vapour service, a lower minimum design pressure maybe accepted.

Existing paragraph 3.3.17 *has been renumbered* 3.3.18.

3.3.19 Ships fitted with a bunker mast in compliance with Pt 4, Ch 6,10 shall be provided with a spool piece in the discharge pipe(s) to the hose(s) of the bunker mast. This spool piece is to be removed and blanking flanges are to be fitted if cargoes other than those listed in Pt 4, Ch 6,10.1.1 are carried. A notice is to be provided, located in a prominent position, clearly indicating when the spool piece is to be removed.

3.4 Terminal fittings at cargo loading stations



1. Connection for delivery of residual cargo
   Connection conform CEFIC
2. Connection for the shore installation to discharge the residual cargo by means of gas pressure
   Connection conform CEFIC

CEFIC stands for European Chemical Industry Council

Fig. 13.3.1
Connection for the delivery of residual cargoes

3.5 Cargo segregation

3.5.3 Spectacle Flanges could be accepted in vapour return systems ~~with the exception of~~ except for tankers carrying toxic cargoes Class 6.1.

3.6 Connections to cargo tanks

3.6.2 Where cargo suction and/or filling lines are led through cargo tanks, the connection to each tank is to be provided with a valve secured to the bulkhead and situated inside the tank it serves, and capable of being operated from the deck. Cargo compatibility is to be assured in the event of pipe failure, (*see* 3.5.4(b)). Where a pump can be used for more than one cargo tank, shut-off valves are to be provided in the pump-room. For Type N tankers this valve is to be fitted not less than 0,60 m above the bottom.

■ *Section 4*

Cargo tanks for Type G tankers

4.2 Cargo tank design

(*Part only shown*)

4.2.1 Scantlings based on internal pressure should be calculated as follows:

(d) The maximum volume of a cargo tank is to comply with Pt 4, Ch 4,3.2.

(e) The length to diameter ratio of a cargo tank is not to exceed 7, *see* Pt 4, Ch 4,3.5.1.

4.10 Stress relieving independent tanks

4.10.1 For independent tanks of carbon and carbon-manganese steel, post-weld heat treatment should be performed after welding~~ if the design temperature is below -10°C. The post-weld heat treatment is to conform to the requirements of Table 13.4.2 in Chapter 13 of the Rules for Materials. For all carbon and carbon-manganese steel. Tanks requiring heat treatment, the requirements of Ch 13,1 and Ch 13,4 of the Rules for Materials are to be complied with~~. The post-weld heat treatment is to conform to the requirements of Ch 13,4.10 and 4.11 in the Rules for Materials. For all carbon and carbon-manganese steel tanks requiring heat treatment, the requirements of Table 13.4.2 in the Rules for Materials are to be complied with.

■ *Section 5*

Cargo tank venting arrangements

5.6 Pressure and temperature control of the cargo for a Type G tanker

5.6.3 For certain highly dangerous cargoes specified in Table C of the ADN, the cargo containment system should be capable of withstanding the full vapour pressure of the cargo under conditions of the upper ambient design temperatures irrespective of any system provided for dealing with boil-off gas, *see* ~~1.3.8~~ 1.3.9 for ~~Table~~ reference.

■ *Section 6*

Cargo tank level gauging equipment and arrangements against overfilling

6.3 Precautions against overfilling

6.3.5 For the maximum allowable cargo related filling limits *see* ADN Table C, Column 11, *see* ~~1.3.8~~ 1.3.9 for reference.

6.3.6 Pressure vessels for Type G tankers may not be filled to more than 91 per cent for uncooled and 95 per cent for cooled cargoes. *See* ADN, Part 3, Table C, ~~c~~Column 11, *see also* ~~1.3.8~~ 1.3.9 for reference.

6.4 Cargo sampling arrangements

6.4.3 On cargo tanks of Type C and N ships these devices are to be of the closed or restricted type. Conform with the requirements of ADN, Table C, Column 13, *see* ~~1.3.8~~ 1.3.9 for reference. The sampling opening is to be in compliance with 6.4.8.

■ *Section 7*
Cargo heating arrangements

7.3 Heating medium

7.3.1 The heating medium is to be compatible with the cargoes to be heated. Where a cargo is highly water reactive, water or steam is not to be used as the medium. For lists of chemicals containing information on water reactivity, *see* ADN, Table C, *see also* ~~1.3.8~~ 1.3.9 for reference.

7.4 Heating circuits

~~*7.4.8* A heat exchanger for toxic cargoes may be waived where the medium is sampled to check for the presence of cargo before it is re-circulated to other services of the ship or into the machinery space. The sampling equipment should be located within the cargo area and be capable of detecting the presence of any toxic cargo being heated. Where this method is used, the coil return should be tested not only at the commencement of heating of a toxic product, but also on the first occasion the coil is subsequent to having carried an unheated toxic cargo.~~

Existing paragraphs 7.4.9 *to* 7.4.12 *have been renumbered* 7.4.8 *to* 7.4.11.

■ *Section 8*
Cargo temperature control arrangements

8.1 Temperature measurement

8.1.2 For the maximum allowable temperature, *see* ADN, Table C , Column 20. *See also* ~~1.3.8~~ 1.3.9 for reference, or as limited for tankers of Types C and N by Pt 4, Ch 6,1.7.

8.2 Water spray system

8.2.5 For cargoes for which a water spray system is mandatory, *see* list of chemicals in ADN, Table C, Column 9~~,~~ (*see also* ~~1.3.8~~ 1.3.9 for reference).

■ *Section 9*
Inert gas systems

9.2 Type C tankers and Type N-closed tankers

9.2.7 The inert gas discharge may be connected with the vapour return system for ships carrying cargoes for which inert gas is not mandatory as per the ADN, Table C, Column 20, additional requirements (*see* 1.3.9 for reference). Two means of isolation as per 9.2.8 or 9.2.9 are to be provided in the connection to the vapour return line. In addition a removable spool piece is to be provided on the cargo tank side of the connection. A notice is to be provided located in a prominent position adjacent to the means of isolation, clearly indicating that the spool piece is to be removed and blanking flanges are to be fitted, when the inert gas system is not in use. The removable spool piece is to be clearly identified (labelled/painted in a distinctive colour) and stowed close to its working position.

9.3 Type G tankers

9.3.6 The equipment should be capable of producing inert gas with an oxygen content at no time greater than 5 per cent by volume. A continuous-reading oxygen content meter should be fitted to the inert gas supply from the equipment and should be fitted with an alarm set at a maximum of 5 per cent oxygen content by volume. The above is subject to the special requirements of Table C of Part 3 of the ADN where a lower maximum oxygen content may be specified for specific cargoes (*see* 1.3.9 for reference).

Part 5, Chapter 14
Requirements for Fusion Welding of Pressure Vessels and Piping

Effective Date 1 July 2014

■ *Section 1*
General

1.1 Scope

1.1.2 Fusion welded pressure vessels will be accepted only if manufactured by firms equipped and competent to undertake the quality of welding required for the Class of vessel proposed. For independent tanks intended for Type G tankers or pressure vessels containing LNG for propulsion purposes, the Manufacturer's works are to be assessed and approved ~~in accordance with the requirements specified in *Materials and Qualification Procedures for Ships*, Book A Procedure MQPS 0-4~~ *see* 2.1.3.

■ *Section 2*
Manufacture and workmanship of fusion welded pressure vessels

2.1 General requirements

2.1.3 Class 1 and Class 2/1 fusion welded pressure vessels constructed to Class 1 and Class 2/1 requirements will be accepted only if manufactured by firms equipped and competent to undertake ~~high quality welding~~ the quality welding required for the Class of vessels proposed. In order that firms may be approved for this purpose, it will be necessary for the Surveyor to visit the works for the purpose of inspecting the welding plant, equipment and procedures, and to arrange for the carrying out of preliminary tests as referred to in 2.1.8. For Class 1 independent cargo tanks on Type G tankers or for pressure vessels containing LNG for propulsion purposes, the Manufacturer's works are to be assessed and approved in accordance with the *Materials and Qualification Procedures for Ships, Book A Procedure MQPS 0-4*, "*Approval of works for the Manufacture of Fusion Welded Pressure Vessels*".

■ *Section 6*
Non-Destructive Examination

6.1 General

6.1.1 Non-Destructive Examination (NDE) of pressure vessels and piping is to be performed in accordance with the requirements of ~~the following~~ Chapters 1 and 13 of the Rules for Materials:

- ~~Ch 13,1,1.11, General welding requirements.~~
- ~~Ch 13,4, 4.12, 13, 14 and 15, Specific requirements for fusion welded pressure vessels.~~
- ~~Ch 13,5,5.5, Specific requirements for pressure pipe work.~~

Part 5, Chapter 15
Steering Gear

Effective Date 1 July 2014

■ *Section 1*
General

1.2 Definitions

1.2.9 **Steering arrangements** means the complete system of components for providing ship directional control.

1.2.10 **Directional control system** means the equipment used to effect changes in ship direction, e.g., the rudder, podded propulsion unit, azimuth thrusters or water jet nozzle. Note that, for podded propulsion systems, azimuth thrusters, water jet systems, or other similar systems for effecting changes in ship direction, it is to be assumed that the units must provide thrust in addition to rotation and hence the directional control system must include the propulsion system.

1.5 Materials

1.5.1 All the ~~steering gear~~ components ~~and the rudder stock~~ used in steering arrangements for ship directional control are to be ~~of sound reliable construction to the Surveyor's satisfaction~~ manufactured in accordance with the Rules for Materials.

■ *Section 2*
Performance

2.1 General

2.1.1 Unless the main steering ~~gear~~ arrangements for ship directional control comprise~~s~~ two or more identical power units, in accordance with 2.1.4, every ship is to be provided with ~~a~~ main steering ~~gear~~ arrangements and ~~an~~ auxiliary steering ~~gear~~ arrangements in accordance with the requirements of the Rules. The main steering ~~gear~~ arrangements and the auxiliary steering ~~gear~~ arrangements are to be so arranged that the failure of one of them will not render the other one inoperative.

2.1.2 The main steering ~~gear and rudder stock is~~ arrangements for ship directional control are to be:

(a) Of adequate strength and capable of steering the ship at maximum ahead service speed which shall be demonstrated in accordance with 5.2;

(b) The parts comprising the steering ~~gear~~ arrangements for ship directional control are to be so dimensioned that they can withstand all the maximum stresses to which they will be subjected in normal operating conditions. The steering ~~gear is~~ arrangements for ship directional control are to be sufficiently strong to withstand abnormal forces (e.g., when the rudder is touching bottom or a bank), the maximum possible damage in such cases being limited to deformation or fracturing of the rudder or stock.

(c) The steering ~~gear is~~ arrangements for ship directional control are to be so designed that a rudder angle of not less than 35° on either side can be obtained. On ships where, due to operation in restricted waters or the passage of locks, a higher degree of manoeuvrability is required, this angle is to be suitably increased;
(d) Where the steering ~~gear is~~ arrangements for ship directional control are manually operated, one complete turn of the hand wheel is to correspond to at least 3° of rudder angle;
(e) Where the steering ~~gear is~~ arrangements for ship directional control are power driven, ~~it is~~ they are to be capable of turning the rudder at an average rate of 4° per second through the entire rudder arc when the rudder is fully immersed and with the ship at maximum ahead service speed.

2.1.3 The auxiliary steering ~~gear is~~ arrangements for ship directional control are to be:
(a) Of adequate strength and capable of steering the ship at a speed of not less than 13 km/h and of being brought speedily into action in an emergency;
(b) The steering ~~gear is~~ arrangements for ship directional control are to be so designed that a rudder angle of not less than 35° on either side can be obtained. On ships where, due to operation in restricted waters or the passage of locks, a higher degree of manoeuvrability is required, this angle is to be suitably increased;
(c) The steering ~~gear~~ arrangements for ship directional control and ~~its~~ their source of power ~~is~~ are to be designed for an operation of not less than 30 minutes and to permit the ship to proceed to a mooring;
(d) Where the steering ~~gear is~~ arrangements for ship directional control are manually operated, one complete turn of the hand wheel is to correspond to at least 3° of rudder angle;
(e) Where the steering ~~gear is~~ arrangements for ship directional control are power driven, ~~it is~~ they are to be capable of turning the rudder at an average rate of 4° per second through the entire rudder arc when the rudder is fully immersed, and with the ship at a speed of not less than 13 km/h.

2.1.4 Where the main steering ~~gear~~ arrangements for ship directional control comprise~~s~~ two or more identical power units, an auxiliary steering gear need not be fitted, provided that:
(a) In a passenger ship, the main steering ~~gear is~~ arrangements for ship directional control are capable of operating the rudder as required by 2.1.2(c) and (e) while any one of the power units is out of operation;
(b) In a cargo ship, the main steering ~~gear is~~ arrangements for ship directional control are capable of operating the rudder as required by 2.1.2(c) and (e) while operating with all power units;
(c) The main steering ~~gear is~~ arrangements for ship directional control are arranged so that after a single failure in its piping system or in one of the power units the defect can be isolated so that steering capability can be maintained or speedily regained.

2.1.5 Power units of ~~M~~main and auxiliary steering ~~gear power units~~ arrangements for ship directional control are to be:
(a) Arranged to re-start immediately by manual initiation;
(b) Capable of being brought into operation from a position on the wheelhouse. In the event of a power failure to any one of the steering gear power units, an audible and visual alarm is to be given on the wheelhouse;
(c) Arranged so that transfer between units can be readily effected.

2.1.6 Steering ~~gear~~ arrangements for ship directional control, other than of the hydraulic type, will be accepted provided the standards are considered equivalent to the requirements of this Section.

2.1.7 Manually operated ~~gears~~ arrangements for ship directional control are only acceptable when the operation does not require an effort exceeding 160 N under normal conditions.

Section 4
Steering control and electric power systems

4.1 Fully powered steering gear

4.1.1 Fully powered steering gears may be of the direct electric or electric/hydraulic type; requirements for the electric and control engineering, *see also* Pt 6, Ch 1,3.7 and ~~Ch 2,9~~ Ch 2,2.8.

Section 5
Testing and trials

5.2 Trials

5.2.1 The steering gear is to be tried out on the trial trip in order to demonstrate to the Surveyor's satisfaction that the requirements of the Rules have been met. The trial is to include the operation of the following:
(a) The steering gear, including demonstration of the performances required by 2.1.2(d) and (e) and 2.1.3(d) and (e):
  - For the main steering gear trial, the propeller pitch of controllable pitch propellers is to be at the maximum design pitch approved for the maximum continuous ahead RPM;
  - ~~If the ship cannot be tested at the deepest draught,~~ During navigation tests ships other than passenger ships shall be loaded to at least 70 per cent of their tonnage and loading. Passenger ships are to be tested at their deepest draught. If a ship cannot be tested under the above stipulations alternative trial conditions may be specially considered. In this case, for the main steering gear trial, the speed of the ship corresponding to the maximum continuous revolutions of the main engine should apply.

(b) The steering gear power units, including transfer between steering gear power units;
c) The isolation of one power actuating system, checking the time for regaining steering capability;
(d) The operation of the auxiliary steering gear as required by 2.1.3(c);

(e) The steering gear controls, including transfer of control and local control;
(f) The alarms and indicators;
(g) Where the steering gear is designed to avoid hydraulic locking, this feature shall be demonstrated.

Test items (f) and (g) may be effected at the dockside.

5.2.2 The ability of the machinery to reverse the direction of propeller thrust in sufficient time and bring the ship to rest within a reasonable distance from maximum ahead service speed is to be demonstrated and recorded.

Part 5, Chapter 16

Azimuth Thrusters

Effective Date 1 July 2014

Section 2
Performance

2.1 General

2.1.2 For vessels with multiple azimuthing thrusters, the requirement for auxiliary steering arrangements in Ch 15,2 is to be achieved by equipping each of the azimuthing thrusters with its own dedicated and independent steering gear control system and power actuating system. Consideration will be given to alternative arrangements providing equivalence can be demonstrated.

~~*2.1.2*~~ *2.1.3* In addition to the requirements of Chapter 15, the azimuthing mechanism is to be capable of a ~~maximum~~ rotational speed of not less than 1,5 rev/min.

2.1.4 The steering arrangements are to be capable of changing the direction of the ship's directional control system from one side to the other at declared steering angle limits at an average rotational speed of not less than 0,4 rev/min, with the ship running ahead at maximum ahead service speed.

Section 5
Electrical equipment

5.3 Distribution arrangements

5.3.1 Thruster auxiliaries and controls are to be served by individual circuits. Services that are duplicated are to be separated throughout their length as widely as is practicable and without the use of common feeders, transformers, ~~convertors~~ converters, protective devices or control circuits.

5.4 Auxiliary supplies

(*Part only shown*)

5.4.1 Where the auxiliary services and thruster units are supplied from a common source, the following requirements are to be complied with:

(a) The voltage regulation and current sharing requirements defined in Pt 6, Ch 2,4.5 are to be maintained over the full range of power factors that may occur in service.
(b) Auxiliary equipment and services are to operate with any waveform distortion introduced by ~~convertors~~ converters without deleterious effect (this may be achieved by the provision of suitably filtered/converted supplies).

Part 5, Chapter 18

Elevating Wheelhouse Systems

Effective Date 1 July 2014

Section 2
Pumping and piping

2.2 Hydraulic pumps

2.2.1 A standby hydraulic pump is to be provided for dry cargo ships.

Section numbering in brackets reflects any Section renumbering necessitated by any of the Notices that update the current version of the Rules for Inland Waterways Ships.

Part 5, Chapter 2

1.1.2	Reference to Section 10 *now reads* Section 11
4.1.1 now *5.1.1*	Reference to Section 6 *now reads* Section 7
5.3.2 now *6.3.2*	Reference to paragraph 5.3.1 *now reads* 6.3.1
5.3.2 now *6.3.2*	Reference to paragraph 5.3.1(b) *now reads* 6.3.1(b)
5.3.3 now *6.3.3*	Reference to paragraph 5.3.1 *now reads* 6.3.1
5.4.2 now *6.4.2*	Reference to sub-Section 5.2 *now reads* 6.2
5.4.2 now *6.4.2*	Reference to sub-Section 5.3 *now reads* 6.3
8.1.2 now *9.1.2*	Reference to sub-Section 8.2 *now reads* 9.2
8.3.1 now *9.3.1*	Reference to paragraph 8.2.1 *now reads* 9.2.1
8.3.1 now *9.3.1*	Reference to paragraph 8.2.2 *now reads* 9.2.2
8.3.4 now *9.3.4*	Reference to paragraph 8.3.1 *now reads* 9.3.1
8.3.4 now *9.3.4*	Reference to paragraph 8.3.3 *now reads* 9.3.3
10.5.2 now *11.4.2*	Reference to paragraph 10.5.1 *now reads* 11.4.1

Part 5, Chapter 9

Cross-references	Reference to Chapter 2,7.3 *now reads* Chapter 2,8.2

Part 5, Chapter 10

4.2.3	Reference to Chapter 2,7.4.3 *now reads* Chapter 2,8.3.3
5.8.1	Reference to Section 9 *now reads* Section 8
8.1.2 now *7.1.2*	Reference to sub-Section 8.2 *now reads* 7.2
9.1.3 now *8.1.3*	Reference to paragraph 9.1.2 *now reads* 8.1.2

Part 5, Chapter 11

2.3.4	Reference to Chapter 10,7 *now reads* Chapter 10,6
2.7.4	Reference to Chapter 10,8 *now reads* Chapter 10,7
Cross-reference	Reference to Chapter 10,10 *now reads* Chapter 10,11

Part 5, Chapter 12

2.4.4	Reference to Chapter 10,9.2 *now reads* Chapter 10,8.2
2.6.2	Reference to Chapter 2,7 *now reads* Chapter 2,8
4.4.5 now *4.4.6*	Reference to paragraph 4.4.6 to 4.4.9 *now reads* 4.4.7 to 4.4.10
4.4.9 now *4.4.10*	Reference to paragraph 4.4.8 *now reads* 4.4.9
Cross-references	Reference to Chapter 10,10 *now reads* Chapter 10,11
10.2.1	Reference to Chapter 2,8 *now reads* Chapter 2,9
11.2.7	Reference to Chapter 10,9 *now reads* Chapter 10,8

Part 5, Chapter 13

2.4.3	Reference to Chapter 10,6 *now reads* Chapter 10,10
3.3.6 now *3.3.7*	Reference to Chapter 10,9 *now reads* Chapter 10,8
3.9.14	Reference to Chapter 10,8 *now reads* Chapter 10,7
7.4.12 now *7.4.11*	Reference to paragraph 7.4.9 *now reads* 7.4.8

Part 5, Chapter 15

3.4.1	Reference to Chapter 10,8 *now reads* Chapter 10,7

Part 5, Chapter 16

3.4.3	Reference to Chapter 10,8 *now reads* Chapter 10,7
6.1.1	Reference to paragraph 2.1.2 *now reads* 2.1.3

Cross-references

Part 5, Chapter 17

3.4.3 Reference to Chapter 10,8 *now reads* Chapter 10,7

Part 5, Chapter 18

2.1.6 Reference to Chapter 10,9 *now reads* Chapter 10, 8

2.2.3 Reference to Chapter 12,9.2.3 *now reads* Chapter 12,4.2.1.

2.3.3 Reference to Chapter 10,8 *now reads* Chapter 10,7

Part 6, Chapter 1

3.2.1 Reference to Part 5, Chapter 2,4 *now reads* Part 5, Chapter 2,5

Part 6, Chapter 2

2.13.1 Reference to Part 5, Chapter 2,8 *now reads* Part 5, Chapter 2,9

© Lloyd’s Register Group Limited 2014
Published by Lloyd’s Register Group Limited
Registered office (Reg. no. 08126909)
71 Fenchurch Street, London, EC3M 4BS
United Kingdom

Lloyd’s Register is a trading name of Lloyd’s Register Group Limited and its subsidiaries. For further details please see http://www.lr.org/entities

Lloyd's Register Group Limited, its affiliates and subsidiaries and their respective officers, employees or agents are, individually and collectively, referred to in this clause as ‘Lloyd's Register’. Lloyd's Register assumes no responsibility and shall not be liable to any person for any loss, damage or expense caused by reliance on the information or advice in this document or howsoever provided, unless that person has signed a contract with the relevant Lloyd's Register entity for the provision of this information or advice and in that case any responsibility or liability is exclusively on the terms and conditions set out in that contract.